Customer No. 27061 Patent
Confirmation No. 8976 Attorney Docket No. GEMS8081.152

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	:	Foo et al.
Serial No.	:	09/682,685
Filed	:	October 5, 2001
For	:	Efficient Multi-Slice Acquisition With Black Blood Contrast In Fast Spin Echo Imaging
Group Art No.	:	3737
Examiner	:	Smith, R.

CERTIFICATION UNDER 37 CFR 1.8(a) and 1.10

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REPLY BRIEF RESPONSIVE TO EXAMINER'S ANSWER MAILED MARCH 20, 2007

Dear Sir:

This Reply Brief is being filed in response to the Examiner's Answer mailed March 20, 2007.

REMARKS

Initially, in an effort to avoid any future confusion, Appellant notes that the Examiner's Answer mailed March 20, 2007 references the Inventors and the Attorney's Docket Number incorrectly. The serial number and filing date of the present application are listed correctly. However, a Petition to Correct Inventorship Under 37 C.F.R. 1.48(a) is currently pending to correct the listed inventors by removing Tin-Su Pan, Steven Woloschek, and H. David He and adding Thomas Foo and Zahi Fayad. Appellant also notes that the correct Attorney's Docket Number is "GEMS8081.152."

In regard to the substance of the Reply Brief of March 20, 2007, claims 21-29 stand rejected under 35 U.S.C. §101 as being directed to non-statutory subject matter. Responsive to Appellant's Appeal Brief filed November 29, 2005, the Examiner addressed some of the remarks proffered by Appellant regarding the rejection under §101. However, the Examiner has not satisfied the burden under MPEP §2106 of establishing that the claims fall within a judicial exception nor the burden of proving that the claims do not recite a practical application.

In particular, the Examiner contended that claims 21-29 are "non-statutory natural phenomena" and are "not directed to a practical application." *Examiner's Answer*, 03/20/2007, pgs. 2-3. The Examiner also argued that Appellant's analogies illustrating the patentability of the claims are "not convincing." *Examiner's Answer*, 03/20/2007, pg. 3. Notwithstanding that it is the Board, not the Examiner, which determines whether remarks on appeal are "convincing," Appellant believes that the Examiner has not properly considered the correspondence between Appellant's analogy and the rejected claims.

Appellant stated that while sticks or branches of wood from a tree, which are a naturally occurring product of nature, are non-statutory subject matter, an arrangement of those same sticks or branches into a chair would be patentable. *Appeal Brief*, 11/29/05 pg. 5. While the Examiner acknowledged that a chair is statutory subject matter, the Examiner concluded that the claimed "pulse sequence which comprises forms of energy / a signal is not well recognized as such." *Examiner's Answer*, 03/20/07, pg. 3. It seems

that the Examiner has misunderstood Appellant's analogy by correlating the claimed pulse sequence with sticks of wood.

With respect to Appellant's analogy, one may equate the occurrence of stray electro-magnetic fields to the wood and the particular claimed pulse sequence arrangement to the chair. That is, naturally occurring electro-magnetic fields, like sticks or branches of wood, are indeed non-statutory subject matter. However, when wood or electro-magnetic fields are directed by the hand of man to a practical application, the result is no longer "naturally occurring," but is a practical application and is, therefore, statutory subject matter. The Examiner provides no support that the claimed pulse sequence "occurs naturally" without the hand of man. It borders on the absurd to suggest that a highly complex and tailored magnetic resonance radio frequency pulse sequence which would achieved the claimed limitations has been documented in nature.

Nevertheless, the Examiner summarily concluded that the claims do not positively set forth any practical application of the pulse sequence. *Examiner's Answer*, 03/20/07 pg. 3. However, MPEP §2106 states that an Examiner bears the burden not only of proving that the claims are directed to a judicial exception, but also that the claims do not recite a practical application. A practical application exists where the claimed invention causes a physical transformation or where the claimed invention produces a useful, concrete, and tangible result. MPEP §2106(IV)(C)(2). The Examiner has not set forth any reasoning directed to any physical transformation or any useful, concrete, or tangible result of the claims. As known in the art, MR pulse sequences are specifically tailored to manipulate the orientation of nuclear spins in a scan subject. Such is a physical transformation. Additionally, the usefulness, repeatability, and tangible nature of MR data resulting from pulse sequences and reconstructed images therefrom are unquestionable. The Examiner has not provided any reasoning to refute these well-accepted notions.

Following this reasoning, claim 21 calls for a pulse sequence *for use in multi-slice MR data acquisition*. A more practical application cannot be more explicit. Further, each element of the claim includes a practical application as to how the pulse sequence is used. For example, the non-selective inversion pulse is applicable to a slab of slices and

the slice-selective re-inversion pulse is applicable to at least a number slices in the slab of slices. The series of excitation pulses is applicable to the at least a number of slices in the slab of slices after an inversion time. One skilled in this art will readily recognize the applicability of this signal claim to the very practical application of spin manipulation, MR data acquisition, and imaging.

As stated in MPEP §2106, in a proper analysis under §101 the claimed invention as a whole must be evaluated for what it is. In this case, when claim 21 is viewed as a whole, it is quite clear that the pulse sequence is for use in multi-slice MR data acquisition. To say that the claims have no practical application ignores how one skilled in the art would understand the claims. The claims at issue do not call for merely an abstract idea, a physical phenomenon, or a law of nature. They call for pulse sequences for use in MR data acquisition -- a very specific compilation.

Furthermore, the Examiner also based the rejection on the assertion that "the claims fail to positively set forth any means for producing the pulses or means for acquiring MR data after the pulses have been applied to a patient's body." *Examiner's Answer*, 03/20/07, pg. 3. The relevance of such statements is unclear. The claims are directed to a pulse sequence. Appellant knows of no naturally occurring instances of the pulses recited in claim 21 - a non-selective pulse, a slice-selective re-inversion pulse, and a series of excitation pulses. Appellant claims that the series of excitation pulses are applicable to the number of slices in the slab of slices *after* an inversion time. How the addition of some formalistic language to the claims would help the patentability of the claims under §101 or §§102 or 103 is not evident.

Therefore, for the reasons stated in Appellant's Appeal Brief filed November 29, 2005, and the reasons stated herein, claims 21-29 are believed directed to a sequence of specific, uniquely tailored pulses that have practicality in magnetic resonance imaging. That is, even though magnetism and RF emissions are naturally occurring phenomena in the abstract sense, when these phenomena are formed as a signal applied to MR imaging, as claimed, these phenomena are manipulated and exploited by the hand of man in a practical application. By generating and manipulating magnetic fields and RF signals through a pulse sequence, the use of these phenomena is new and useful. In this regard, a

"pulse sequence" defines the manner in which these naturally occurring phenomena are to be exploited to reach a new and useful end, namely, the claimed "multi-slice MR data acquisition."

Appellant also notes both the close analogy to the Office issuing patents with patentable "manufacture" claims to a signal on a carrier wave (for example, USP 6,791,971, claim 45; USP 6,078,360, claim 5; USP 6,076,092, claim 35; and USP 5,995,921, claims 20-29), the following issued patents that similarly call for a pulse sequence: see claims 1-4 of USP 6,803,762, claims 21-29 of USP 6,498,946, and claims 9-15 of USP 6,526,307. Accordingly, Appellant respectfully submits that claims 21-29 are directed to statutory subject matter.

Respectfully submitted,

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Dated: May 21, 2007
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APPENDIX OF CLAIMS ON APPEAL

1. (Allowed) A method of multi-slice image acquisition with black-blood contrast comprising:

applying a non-selective inversion pulse;

applying a re-inversion pulse that is slice-selective over a region encompassing a plurality of slice selections;

timing execution of a series of RF excitation pulses such that signal from blood is near a null point; and

acquiring data for the plurality of slice selections.

2. (Allowed) The method of claim 1 wherein the plurality of slice selections include all slice selections in a slab to be imaged.

3. (Allowed) The method of claim 1 wherein the images are acquired over more than a single breath-hold.

4. (Allowed) The method of claim 1 wherein the re-inversion pulse is applied over a region having all slice selections in a slab and data are acquired for all slice selections in the slab using a single re-inversion pulse.

5. (Allowed) The method of claim 1 further comprising creating the inversion pulse with slice thickness given by:

slice thickness = $(Z_1 - Z_n) + 4$ * opslthick,

where Z_1 and Z_n represents spatial locations of first and last slices selected for imaging, and opslthick represents a desired imaging slice thickness.

6. (Allowed) The method of claim 5 further comprising creating the re-inversion pulse with a center centered about a midpoint between Z_1 and Z_n.

7. (Allowed) The method of claim 1 wherein the timing step includes selecting an inversion time TI such that the null point of the blood occurs near a center of the multi-slice acquisition.

8. (Allowed) The method of claim 1 further comprising modifying a flip angle of RF excitation pulses executed before and after an occurrence of the null point of the blood to improve blood suppression.

9. (Allowed) The method of claim 8 further comprising modifying the flip of RF excitation pulses occurring before the null point to slightly less than 90° and those occurring after the null point to slightly more than 90°.

10. (Allowed) A computer program stored on a computer readable storage medium and having a set of instructions that when executed by a computer cause the computer to:

(A) generate and cause application of a non-selective inversion RF pulse to a slab of slices each having a thickness;

(B) generate and cause application of a slice-selective re-inversion RF pulse having a slice thickness greater than the thickness of a single slice;

(C) apply an inversion time;

(D) apply RF excitations; and

(E) acquire MR data.

11. (Allowed) The computer program of claim 10 wherein the slice thickness of the re-inversion pulse is selected greater than the slab of slices to allow for cardiac motion between the application of the slice-selective re-inversion RF pulse, and the acquisition of MR data.

12. (Allowed) The computer program of claim 10 wherein the RF excitations have a flip angle greater than 90° for segments after a null point and less than 90° for segments before the null point.

13. (Allowed) The computer program of claim 10 wherein acts (A) – (E) are carried out over one or more R-R intervals.

14. (Allowed) The computer program of claim 10 wherein the MR data is acquired during mid-diastole of an R-R interval.

15. (Allowed) An MR apparatus to produce consistent contrast in image acquisition comprising:

a magnetic resonance imaging (MRI) system having a plurality of gradient coils positioned about a bore of a magnet to impress a polarizing magnetic field and an RF transceiver system and an RF switch controlled by a pulse module to transmit RF signals to an RF coil assembly to acquire MR images; and

a computer programmed to apply a pulse sequence having:

a non-selective inversion pulse to invert spins in a longitudinal direction across an entire slab of slices;

a slice-selective re-inversion pulse having an implied width at least as large as that of the non-selective inversion pulse; and

a series of excitation pulses spaced apart from the slice-selective re-inversion pulse by an inversion time.

16. (Allowed) The MR apparatus of claim 15 wherein the slice-selective re-inversion pulse of the pulse sequence is further defined as having a width greater than that of the non-selective inversion pulse to extend on either side of the non-selective inversion pulse.

17. (Allowed) The MR apparatus of claim 16 wherein the slice-selective re-inversion pulse extends approximately twice the nominal slice thickness on either side of the non-selective inversion pulse.

18. (Allowed) The MR apparatus of claim 15 wherein the inversion time of the pulse sequence is selected such that blood signal is close to a null point.

19. (Allowed) The MR apparatus of claim 18 wherein the series of excitation pulses have therein excitation pulses with differing flip angles.

20. (Allowed) The MR apparatus of claim 19 wherein excitation pulses occurring near a mid-point of the series have a flip angle near 90° and excitation pulses occurring before a mid-point have a flip angle less than 90° and excitation pulses occurring after the mid-point have a flip angle more than 90°.

21. (On Appeal) A pulse sequence for use in multi-slice MR data acquisition comprising:

a non-selective inversion pulse applicable to a slab of slices;

a slice-selective re-inversion pulse applicable to at least a number of slices in the slab of slices; and

a series of excitation pulses applicable to the at least a number of slices in the slab of slices after an inversion time.

22. (On Appeal) The pulse sequence of claim 21 wherein the inversion time is selected to allow signal from blood in a mid-point of the at least a number of slices to approach a null point.

23. (On Appeal) The pulse sequence of claim 21 wherein the at least a number of slices includes all slices in the slab of slices.

24. (On Appeal) The pulse sequence of claim 21 wherein the at least a number of slices includes fewer slices than those in the slab of slices but more than one.

25. (On Appeal) The pulse sequence of claim 21 wherein the at least a number of slices includes more slices than those in the slab of slices.

26. (On Appeal) The pulse sequence of claim 21 wherein the non-selective inversion pulse has a thickness given by:

slice thickness = $(Z_1 - Z_n) + 4 *$ opslthick,

where Z_1 and Z_n represents spatial locations of first and last slices selected for imaging, and opslthick represents a desired imaging slice thickness.

27. (On Appeal) The pulse sequence of claim 26 wherein the slice-selective re-inversion pulse has a center centered about a mid-point between Z_1 and Z_n.

28. (On Appeal) The pulse sequence of claim 21 wherein the series of excitation pulses have varying flip angles.

29. (On Appeal) The pulse sequence of claim 28 wherein excitation pulses that occur before a mid-point of the series have a flip angle of less than 90°, those near the mid-point have a flip angle near or at 90°, and those that occur after the mid-point have a flip angle greater than 90°.